

05/30/00

 PTO  
 05/26/00  
 05/26/00

JC935 U.S. PTO

05/26/00

Please type a plus sign (+) inside this box → +

 Approved for use through 09/30/2000. OMB 0651-0046  
 Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

<b>UTILITY</b>	
<b>PATENT APPLICATION TRANSMITTAL</b>	
<i>(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))</i>	
Attorney Docket No.	PD-99W166
First Inventor or Application Identifier	Linder
Title	"Low Noise, Low Distortion, Muxable"
Express Mail Label No.	EK444529150US

<b>APPLICATION ELEMENTS</b>		<b>ADDRESS TO:</b>	
See MPEP chapter 600 concerning utility patent application contents.		Assistant Commissioner for Patents Box Patent Application Washington, DC 20231	
1. <input checked="" type="checkbox"/> * Fee Transmittal Form (e.g., PTO/SB/17) (Submit an original and a duplicate for fee processing)	5. <input type="checkbox"/> Microfiche Computer Program (Appendix)	<b>ACCOMPANYING APPLICATION PARTS</b> 7. <input checked="" type="checkbox"/> Assignment Papers (cover sheet & document(s)) 8. <input checked="" type="checkbox"/> 37 C.F.R. § 3.73(b) Statement (if applicable, all necessary) <input type="checkbox"/> Power of Attorney 9. <input type="checkbox"/> English Translation Document (if applicable) 10. <input type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input type="checkbox"/> Copies of IDS Citations 11. <input type="checkbox"/> Preliminary Amendment 12. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) (Should be specifically itemized) * Small Entity Statement filed in prior application, Status still proper and desired (PTO/SB/09-12) 13. <input type="checkbox"/> Certified Copy of Priority Document(s) (if foreign priority is claimed) 14. <input type="checkbox"/> Other: "Gilbert Mixer Signal Processing System and Method with AGC Functionality" 15. <input type="checkbox"/>	
2. <input checked="" type="checkbox"/> Specification [Total Pages 13] (preferred arrangement set forth below) - Descriptive title of the Invention - Cross References to Related Applications - Statement Regarding Fed sponsored R & D - Reference to Microfiche Appendix - Background of the Invention - Brief Summary of the Invention - Brief Description of the Drawings (if filed) - Detailed Description - Claim(s) - Abstract of the Disclosure	6. Nucleotide and/or Amino Acid Sequence Submission (if applicable) a. <input type="checkbox"/> Computer Readable Copy b. <input type="checkbox"/> Paper Copy (identical to computer copy) c. <input type="checkbox"/> Statement verifying identity of above copies		
3. <input checked="" type="checkbox"/> Drawings (35 U.S.C. 113) [Total Sheets 6]			
4. Oath or Declaration [Total Pages 3] a. <input checked="" type="checkbox"/> Newly executed (original or copy) b. <input type="checkbox"/> Copy from a prior application (37 C.F.R. § 1.63(d)) (for continuation/divisional with Box 16 completed) L. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).			
<b>* NOTE FOR ITEMS 1, 13 &amp; 15 IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.29)</b>			

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) or prior application No: \_\_\_\_\_  
 Prior application information: Examiner \_\_\_\_\_ Group / Art Unit: \_\_\_\_\_

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

<b>17. CORRESPONDENCE ADDRESS</b>					
<input type="checkbox"/> Customer Number or Bar Code Label (Insert Customer No. or Attach bar code label here) or <input checked="" type="checkbox"/> Correspondence address below					
Name	Leonard A. Alkov, Esq. Raytheon Company				
Address	P.O. Box 902 (E1/E150)				
City	El Segundo	State	CA	Zip Code	90245-0902
Country	U.S.A.	Telephone	310.647.2577	Fax	310.647.2616

Name (Print/Type)	Leonard A. Alkov	Registration No. (Attorney/Agent)	30,021
Signature	<i>Leonard A. Alkov</i>	Date	05/26/00

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231.

**LOW NOISE, LOW DISTORTION, MUXABLE GILBERT  
MIXER SIGNAL PROCESSING SYSTEM AND  
METHOD WITH AGC FUNCTIONALITY**

**Lloyd F. Linder  
Clifford N. Duong  
Don C. Devendorf**

**LOW NOISE, LOW DISTORTION, MUXABLE GILBERT  
MIXER SIGNAL PROCESSING SYSTEM AND  
METHOD WITH AGC FUNCTIONALITY**

5

This invention was made with Government support under Contract No. F30602-97-C-0223 awarded by the Air Force. The Government has certain rights in this invention.

10

**BACKGROUND OF THE INVENTION**

Field of the Invention:

The present invention relates to electronic circuits and systems. More specifically, the present invention relates to radio frequency receivers and transceivers used in communication applications.

Description of the Related Art:

For future military and commercial applications there may be a need for a radio capable of operating over a wide band of frequencies. This would ordinarily involve switching or multiplexing the received signal to one of N channels for subsequent gain control and mixing operations. However, it would be difficult for a single radio frequency (RF) switch to cover either the RF or IF frequency range.

25

Accordingly, a more promising approach would be to use a number of RF switches to selectively direct a received RF signal to an appropriate intermediate frequency processing stage. These switches would typically be single pole, multi-throw solid state switches implemented in silicon or Gallium Arsenide (GaAs). The switches would typically be disposed on a separate chip relative to the RF receiver in a 50-ohm environment.

Unfortunately, in addition to requiring complicated circuitry, this approach would present difficult power, third order intercept (intermodulation product distortion), noise figure, insertion loss and interchannel isolation issues. In addition, the switches would have to operate over a wide RF band or a wide IF band, both of which are difficult to achieve.

Hence, there is a developing need in the art for a system or method for providing a radio capable of operating over a wide band with minimal power consumption and circuit complexity. More specifically, there is a growing need in the art for a system or method for switching or multiplexing a received signal to one of N channels for subsequent gain control and mixing operations for individual and simultaneous output via a single stage at low power.

### SUMMARY OF THE INVENTION

The need in the art is addressed by the signal processing system and method of the present invention. The inventive system includes a first circuit for distributing an input signal between two or more channels in a current mode of operation. A second circuit is disposed in each of the channels for processing the input signal and providing an output signal in response thereto. A third circuit is provided to combine the signals output by the processing circuit. A fourth circuit is included for controlling the first and the third circuits.

In a specific illustrative embodiment, the system further includes a radio frequency stage for downconverting a received signal and providing the input signal in response thereto. In the specific embodiment, the first circuit includes a mixing circuit. The mixing circuit includes Gilbert cells and circuitry for providing automatic gain control for each of the channels individually. The Gilbert cells and the automatic gain control circuitry are driven by a transconductance amplifier and therefore operate in a current mode. Differential digital automatic gain control signals are provided in response to a channel select signal from a digital control circuit. The inventive circuit

provides multiple IF channels which may be filtered individually. The invention thereby provides wide band operation in a simple low power single stage while the current mode thereof is effective in the reduction of insertion loss.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of an illustrative implementation of a receiver incorporating the signal processing system of the present invention.

Fig. 2 is a block diagram showing an illustrative implementation of the mixing circuit of Fig. 1 in accordance with the present teachings.

Fig. 3 is a diagram showing an illustrative implementation of the digital automatic gain control circuit in more detail.

Fig. 4 is a diagram showing an illustrative implementation of the channel select multiplexer.

Fig. 5 is a diagram showing automatic gain control circuits, Gilbert cells, transconductance amplifier and load resistors of the mixer of Fig. 1 in more detail.

Fig. 6 is a schematic diagram of an illustrative implementation of an automatic gain control circuit of Fig. 5.

Fig. 7 is a schematic diagram of an illustrative implementation of a Gilbert cell of Fig. 5.

Fig. 8 is a block diagram of an illustrative implementation of the local oscillator multiplexer.

## DESCRIPTION OF THE INVENTION

Illustrative embodiments and exemplary applications will now be described with reference to the accompanying drawings to disclose the advantageous teachings of the present invention.

While the present invention is described herein with reference to illustrative embodiments for particular applications, it should be understood that the invention is not limited thereto. Those having ordinary skill in the art and access to the teachings provided herein will recognize additional modifications, applications, and embodiments within the scope thereof and additional fields in which the present invention would be of significant utility.

Fig. 1 is a block diagram of an illustrative implementation of a receiver incorporating the signal processing system of the present invention. The system 10 includes an RF front end comprising an antenna 12, a conventional preselect filter 14, a low noise amplifier (LNA) 16 and an image rejection filter 18. The preselect filter 14 narrows the receive band down to the band of interest. Signals in the band of interest are amplified by the LNA 16 and images therein are rejected by the image rejection filter 18.

In accordance with the present teachings, the output of the image rejection filter 18 is applied to a mixing circuit 20 designed in accordance with the present teachings. The mixer 20 is controlled by a digital controller 30. The digital controller 30 may be implemented with software in a microprocessor, a serial controller, a field programmable gate array, application specific integrated circuit or suitable discrete logic. Those skilled in the art will appreciate that the present teachings are not limited to the use of a digital AGC circuit nor are the present teachings limited to a digital controller. Other suitable analog equivalents may be used for this purpose depending on the requirements of a given application.

The controller 30 provides mixer, RF automatic gain control (AGC), and RF channel select signals to the mixer 20.

Fig. 2 is a block diagram showing an illustrative implementation of the mixing circuit of Fig. 1 in accordance with the present teachings. As shown in Fig. 2, the mixing circuit 20 includes a digital automatic gain control circuit (DAGC) 70, which provides global gain control of the signal output by the filter 18.

Fig. 3 is a diagram showing an illustrative implementation of the digital automatic gain control circuit in more detail. The DAGC 70 may be implemented with a digital-to-analog converter (DAC) 72 and a transconductance (voltage to current) amplifier 74. The DAGC 70 outputs a gain controlled current control signal to a channel select multiplexer 80.

Fig. 4 is a diagram showing an illustrative implementation of the channel select multiplexer. The channel select multiplexer 80 may be implemented with a plurality of switches 82, 84, 86, 88 and 89 each of which receive the output of the DAGC 80 and output a differential automatic gain control current control signal in response to an associated channel select signal supplied by the controller 30 of Fig. 1.

Returning to Fig. 2, the differential outputs of the channel select multiplexer 80 are applied to a respective automatic gain control (AGC) circuit in a bank of AGCs 90 in the mixing circuit 20. The AGCs 90 control the current therethrough in response to the control signal received thereby from the DAGC 70 via the channel select multiplexer 80. All but one of the AGCs in the bank of AGCs 90 are connected to an associated Gilbert cell in a bank of Gilbert cells 100. The cells 100 receive a local oscillator signal from a local oscillator source 40 (Fig. 1) via a local oscillator multiplexer 110. Current for the Gilbert cells 100 is supplied by a second transconductance amplifier 120 and adjusted by the AGCs 90 in proportion to the signal supplied by the DAGC 70.

Fig. 5 is a diagram showing automatic gain control circuits, Gilbert cells, transconductance amplifier and load resistors of the mixer of Fig. 1 in more detail. The system 10 is implemented with five channels. Those skilled in the art will appreciate that the present teachings are not limited to the number of channels employed. In theory, the number of IF sections that can be added will depend on the effects of the parasitic capacitance at the MUX/AGC stage at the RF stage output, and the effect on the bandwidth of the local oscillator driver. A long as adding more stages does not band limit the local oscillator severely or band limit the RF signal path (or degrade the intercept performance there), then more stages can be added until such events occur.

Each channel pushes differential current through the second transconductance amplifier 120 and includes an AGC 92, 94, 96, 98 or 99.

In the illustrative embodiment, the transconductance amplifier 120 is implemented with first and second bipolar (NPN) transistors 121 and 122 connected in an emitter degenerated differential pair configuration. The collector of each transistor 121 and 122 provides one of the two differential inputs to each of the AGCs 90. The base terminals of the first transistor 121 and the second transistor 122 in the amplifier 120 are supplied by a bias supply via first and second resistors 123 and 124, respectively. The emitter terminals of the first transistor 121 and the second transistor 122 in the amplifier 120 are connected to ground via first and second current sources 125 and 126, respectively. In addition, the emitter terminals of the first transistor 121 and the second transistor 122 are connected via a resistor 127. In addition, the base terminal of the second transistor 122 is filtered by a capacitor 128 connected to ground.

As mentioned above, the gain of the current through each of the AGCs 90 is set by the gain control signal supplied by the controller 30 via the DAGC 70. Each AGC is selected via the multiplexer 80 by a channel select signal supplied by the controller 30 as described above.

Fig. 6 is a schematic diagram of an illustrative implementation of an automatic gain control circuit of Fig. 5. The gain control circuits may be implemented in accordance with the teachings of U.S. Patent No. 6,040,731 issued March 21, 2000, to Chen *et al.* and entitled **Differential Pair Gain Control Stage**, the teachings of which are incorporated herein by reference. In the illustrative implementation, each AGC (e.g. 99) includes, for each input, a first bipolar (NPN) transistor 152 and a second transistor 153 (or 154 and 155) connected in a differential pair configuration to receive an AGC control signal (e.g., AGC5) from the DAGC 70 as mentioned above. The emitter terminals of each transistor pair are connected to one of the differential inputs from the transconductance amplifier 120. One transistor in each pair 153 and 154 is connected to a source of supply voltage ( $V_{cc}$ ) via a bias resistor 156 or 157, respectively. The collector terminals of the second transistor in each pair 152 and 155 provide the differential outputs of the AGC.

Channels 1, 2, 4 and 5 include a Gilbert cell 102, 104, 108 and 109 respectively. Gilbert cells are well known in the art. See for example U. S. Patent No. 3,689,752 issued 09/05/72 to Barrie Gilbert and entitled **Four Quadrant Multiplier Circuit**, the teachings of which are incorporated herein by reference.

Fig. 7 is a schematic diagram of an illustrative implementation of a Gilbert cell of Fig. 5. Each cell (e.g., 109) includes a pair of transistors 162/164 and 166/168 for each differential input connected in a Differential pair configuration. Each base terminal of each transistor in each pair is connected to and LO in Figure 5, which is generated in the LO MUX 110 in Figure 2, which creates the multiple LO signals in Figure 8.

The emitter terminals of the two transistors in each pair are connected to one of the differential inputs from an associated AGC. The collector terminal of each transistor in each pair is tied to a collector terminal of the other pair and provides one of the differential outputs of the cell.

As mentioned above, the cells 100 receive a local oscillator signal from a local oscillator source 40 (Fig. 1) via a local oscillator multiplexer 110.

Fig. 8 is a block diagram of an illustrative implementation of the local oscillator multiplexer. The local oscillator multiplexer 110 includes a 2:1 multiplexer 170 which receives internal local oscillator (LO) and external LO inputs from the local oscillator source 40 of Fig. 1 and a 1 bit select input from the digital controller 30. The LO source 40 can be either generated internally on the chip in a phase lock loop (PLL) (defined as INTERNAL LO), or externally off the chip (EXTERNAL LO). The output of the multiplexer 170 is provided to a 1:4 demultiplexer 174 via an isolation and squaring circuit 172. A digital circuit 176 provides two bit LO select control for the 1:4 demultiplexer 174. Digital circuit 176 is a two-bit decode, and can be part of the control circuit 30. I did not receive Figure 9 in the packet. The DMUX 174 is in Figure 8, and it is a conventional design. Two digital bits select one of the four paths (the fifth path is a by-pass mode).

The demultiplexer 174 provides input to each of four local oscillator drivers 178, 180, 182 and 184. Each driver may be of conventional design and includes squaring circuitry as is common in the art. The four drivers 178, 180, 182 and 184 output LO1, LO2, LO4 and LO5 which are used to drive the Gilbert cells 102, 104, 108 and 109 of Fig. 5 respectively.

The AGC 96 in the third channel draws differential gain controlled current from an RF amplifier 106 consisting in the illustrative embodiment of two DC biased transistors 105 and 107 arranged in a cascode configuration.

The differential outputs of the Gilbert cells 102, 104, 108 and 109 and the RF amplifier 106 draw current from the source  $V_{cc}$  via an associated load resistor  $R_L$  for the transconductance amplifier 120. Differential outputs for each channel are provided at the connection with the associated load resistor  $R_L$ . The Gilbert cells mix the local oscillator signal and the RF signal from the AGC circuits to provide differential outputs

for each channel at the local oscillator frequency plus or minus the radio frequency:  $LO + RF$  and  $LO - RF$ .

Returning to Fig. 1, as discussed above, the mixing circuit 20 provides a 1:N  
5 multiplexing of the output of the filter 18 to one of several channels in response to a  
local oscillator 40 and signals from the controller 30. That is, the output of the mixer 20  
is distributed to one of N channels (where  $N = 5$  in the illustrative embodiment of Fig.  
1). In each channel, a filter 45, 46, 47, 48 or 49 is disposed. The filters 45, 46, 47, 48  
and 49 are intermediate frequency (IF) filters which pass signals over various  
10 bandwidths at various frequencies as required for a given multi-band application.

The outputs of the filters are combined by an N:1 demultiplexer 50 and input to  
an intermediate frequency (IF) amplifier 52. The output of the IF amplifier 52 is  
processed by an anti-aliasing filter 54 and digitized by an analog-to-digital converter  
15 (ADC) 56. The output of the ADC is input to a signal processor 58 which outputs to a  
personal computer (PC) 60 or other output device as may be appropriate for a given  
application. The signal processor 58 provides control signals for the system 10 via the  
digital controller 30. That is, in accordance with the present teachings, the signal  
processor 58 provides channel select, AGC select and local oscillator select control  
20 signals for the system 10 via the digital controller 30. The signal processor can do fast  
Fourier transforms on the received signal, correlate a spread spectrum PN-code,  
demodulate the received signal, determine chirp rates of received signals, etc. The signal  
processor is application specific, to perform the necessary processing for a given  
application. The PC 60 allows for selective display of the information output by the  
25 signal processor 58 and/or additional data processing.

The system 10 may be implemented on a single application specific integrated  
circuit (ASIC). Those skilled in the art will appreciate that flexibility is built into the  
ASIC, through the multiplexing function, providing the ability to use off-chip inductive-  
30 capacitive (LC) or surface acoustic wave (SAW) filters, or on-chip active filters.

In addition, the system may be implemented with a by-pass mode, by which the received signal is not mixed to an IF frequency, but passes instead directly through on-chip (to IF circuitry prior) to an external ADC. The added multiplexing capability of the AGC/low voltage Gilbert mixer allows this flexibility without compromising performance. A key to this performance feature is due to the fact that multiplexing is accomplished in current mode in the RF signal path on-chip.

Since the MUX is integrated in current mode in the RF path, additional measures can be taken to help the isolation. In the case of this architecture, the local oscillator, for the unused channels is blanked so that RF leakage will not mix into the IF bandwidth of interest.

Thus, the present invention has been described herein with reference to a particular embodiment for a particular application. Those having ordinary skill in the art and access to the present teachings will recognize additional modifications, applications and embodiments within the scope thereof.

It is therefore intended by the appended claims to cover any and all such applications, modifications and embodiments within the scope of the present invention.

Accordingly,

WHAT IS CLAIMED IS:

# CLAIMS

1. A signal processing system comprising:  
first means for distributing an input signal between two or more channels in a  
5 current mode of operation;  
second means disposed in each of said channels for processing said input signal  
and providing an output signal in response thereto;  
third means for combining the signals output by said processing means; and  
fourth means for controlling said first and said third means.
2. The invention of Claim 1 further including a radio frequency stage for  
downconverting a received signal and providing said input signal in response thereto.
3. The invention of Claim 1 wherein said first means includes a mixing  
circuit.
4. The invention of Claim 3 wherein said mixing circuit further includes  
means for providing automatic gain control for each of said channels individually.
5. The invention of Claim 4 wherein said means for providing automatic  
gain control operates in a current mode.
6. The invention of Claim 5 wherein said means for providing automatic  
gain control includes a digital automatic gain control circuit.
7. The invention of Claim 6 further including means for selectively  
providing differential digital automatic gain control signals in response to a channel  
select signal.
8. The invention of Claim 3 wherein said mixing circuit further includes  
means for mixing said input signal with a mixing signal.

9. The invention of Claim 8 wherein said mixing circuit operates in a current mode.

10. The invention of Claim 9 wherein said mixing circuit further includes means for mixing said input signal with plural mixing signals.

11. The invention of Claim 10 wherein said mixing circuit includes at least one Gilbert cell.

12. The invention of Claim 11 wherein said mixing circuit includes a transconductance amplifier.

13. The invention of Claim 12 wherein said mixing circuit includes an automatic gain control circuit.

14. The invention of Claim 1 wherein said second means includes first and second filters disposed in a first and a second of said channels respectively.

15. A receiver comprising:  
a radio frequency stage for downconverting a received signal and providing said input signal in response thereto;

- 5 first means for distributing said input signal between two or more channels in a current mode of operation, said first means including a mixing circuit having  
a Gilbert cell for each channel,  
an automatic gain control circuit for each channel in communication with a respective one of said Gilbert cells, and  
10 a transconductance amplifier in communication with said automatic gain control circuits;

second means disposed in each of said channels for processing said input signal and providing an output signal in response thereto, second means including first and second filters disposed in a first and a second of said channels respectively;

15           third means for combining the signals output by said processing means; and  
          fourth means for controlling said first and said third means.

16.       A signal processing method comprising the steps of:  
          distributing an input signal between two or more channels in a current mode of  
operation;

          processing said input signal and providing an output signal in response thereto;  
5         combining the signals output by said processing means; and  
          controlling said first and said third means.

10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100  
101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111  
112  
113  
114  
115  
116  
117  
118  
119  
120  
121  
122  
123  
124  
125  
126  
127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137  
138  
139  
140  
141  
142  
143  
144  
145  
146  
147  
148  
149  
150  
151  
152  
153  
154  
155  
156  
157  
158  
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169  
170  
171  
172  
173  
174  
175  
176  
177  
178  
179  
180  
181  
182  
183  
184  
185  
186  
187  
188  
189  
190  
191  
192  
193  
194  
195  
196  
197  
198  
199  
200  
201  
202  
203  
204  
205  
206  
207  
208  
209  
210  
211  
212  
213  
214  
215  
216  
217  
218  
219  
220  
221  
222  
223  
224  
225  
226  
227  
228  
229  
230  
231  
232  
233  
234  
235  
236  
237  
238  
239  
240  
241  
242  
243  
244  
245  
246  
247  
248  
249  
250  
251  
252  
253  
254  
255  
256  
257  
258  
259  
260  
261  
262  
263  
264  
265  
266  
267  
268  
269  
270  
271  
272  
273  
274  
275  
276  
277  
278  
279  
280  
281  
282  
283  
284  
285  
286  
287  
288  
289  
290  
291  
292  
293  
294  
295  
296  
297  
298  
299  
300  
301  
302  
303  
304  
305  
306  
307  
308  
309  
310  
311  
312  
313  
314  
315  
316  
317  
318  
319  
320  
321  
322  
323  
324  
325  
326  
327  
328  
329  
330  
331  
332  
333  
334  
335  
336  
337  
338  
339  
340  
341  
342  
343  
344  
345  
346  
347  
348  
349  
350  
351  
352  
353  
354  
355  
356  
357  
358  
359  
360  
361  
362  
363  
364  
365  
366  
367  
368  
369  
370  
371  
372  
373  
374  
375  
376  
377  
378  
379  
380  
381  
382  
383  
384  
385  
386  
387  
388  
389  
390  
391  
392  
393  
394  
395  
396  
397  
398  
399  
400  
401  
402  
403  
404  
405  
406  
407  
408  
409  
410  
411  
412  
413  
414  
415  
416  
417  
418  
419  
420  
421  
422  
423  
424  
425  
426  
427  
428  
429  
430  
431  
432  
433  
434  
435  
436  
437  
438  
439  
440  
441  
442  
443  
444  
445  
446  
447  
448  
449  
450  
451  
452  
453  
454  
455  
456  
457  
458  
459  
460  
461  
462  
463  
464  
465  
466  
467  
468  
469  
470  
471  
472  
473  
474  
475  
476  
477  
478  
479  
480  
481  
482  
483  
484  
485  
486  
487  
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500  
501  
502  
503  
504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543  
544  
545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569  
570  
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594  
595  
596  
597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630  
631  
632  
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668  
669  
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695  
696  
697  
698  
699  
700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716  
717  
718  
719  
720  
721  
722  
723  
724  
725  
726  
727  
728  
729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747  
748  
749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761  
762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773  
774  
775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793  
794  
795  
796  
797  
798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821  
822  
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842  
843  
844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861  
862  
863  
864  
865  
866  
867  
868  
869  
870  
871  
872  
873  
874  
875  
876  
877  
878  
879  
880  
881  
882  
883  
884  
885  
886  
887  
888  
889  
890  
891  
892  
893  
894  
895  
896  
897  
898  
899  
900  
901  
902  
903  
904  
905  
906  
907  
908  
909  
910  
911  
912  
913  
914  
915  
916  
917  
918  
919  
920  
921  
922  
923  
924  
925  
926  
927  
928  
929  
930  
931  
932  
933  
934  
935  
936  
937  
938  
939  
940  
941  
942  
943  
944  
945  
946  
947  
948  
949  
950  
951  
952  
953  
954  
955  
956  
957  
958  
959  
960  
961  
962  
963  
964  
965  
966  
967  
968  
969  
970  
971  
972  
973  
974  
975  
976  
977  
978  
979  
980  
981  
982  
983  
984  
985  
986  
987  
988  
989  
990  
991  
992  
993  
994  
995  
996  
997  
998  
999  
1000  
1001  
1002  
1003  
1004  
1005  
1006  
1007  
1008  
1009  
1010  
1011  
1012  
1013  
1014  
1015  
1016  
1017  
1018  
1019  
1020  
1021  
1022  
1023  
1024  
1025  
1026  
1027  
1028  
1029  
1030  
1031  
1032  
1033  
1034  
1035  
1036  
1037  
1038  
1039  
1040  
1041  
1042  
1043  
1044  
1045  
1046  
1047  
1048  
1049  
1050  
1051  
1052  
1053  
1054  
1055  
1056  
1057  
1058  
1059  
1060  
1061  
1062  
1063  
1064  
1065  
1066  
1067  
1068  
1069  
1070  
1071  
1072  
1073  
1074  
1075  
1076  
1077  
1078  
1079  
1080  
1081  
1082  
1083  
1084  
1085  
1086  
1087  
1088  
1089  
1090  
1091  
1092  
1093  
1094  
1095  
1096  
1097  
1098  
1099  
1100  
1101  
1102  
1103  
1104  
1105  
1106  
1107  
1108  
1109  
1110  
1111  
1112  
1113  
1114  
1115  
1116  
1117  
1118  
1119  
1120  
1121  
1122  
1123  
1124  
1125  
1126  
1127  
1128  
1129  
1130  
1131  
1132  
1133  
1134  
1135  
1136  
1137  
1138  
1139  
1140  
1141  
1142  
1143  
1144  
1145  
1146  
1147  
1148  
1149  
1150  
1151  
1152  
1153  
1154  
1155  
1156  
1157  
1158  
1159  
1160  
1161  
1162  
1163  
1164  
1165  
1166  
1167  
1168  
1169  
1170  
1171  
1172  
1173  
1174  
1175  
1176  
1177  
1178  
1179  
1180  
1181  
1182  
1183  
1184  
1185  
1186  
1187  
1188  
1189  
1190  
1191  
1192  
1193  
1194  
1195  
1196  
1197  
1198  
1199  
1200  
1201  
1202  
1203  
1204  
1205  
1206  
1207  
1208  
1209  
1210  
1211  
1212  
1213  
1214  
1215  
1216  
1217  
1218  
1219  
1220  
1221  
1222  
1223  
1224  
1225  
1226  
1227  
1228  
1229  
1230  
1231  
1232  
1233  
1234  
1235  
1236  
1237  
1238  
1239  
1240  
1241  
1242  
1243  
1244  
1245  
1246  
1247  
1248  
1249  
1250  
1251  
1252  
1253  
1254  
1255  
1256  
1257  
1258  
1259  
1260  
1261  
1262  
1263  
1264  
1265  
1266  
1267  
1268  
1269  
1270  
1271  
1272  
1273  
1274  
1275  
1276  
1277  
1278  
1279  
1280  
1281  
1282  
1283  
1284  
1285  
1286  
1287  
1288  
1289  
1290  
1291  
1292  
1293  
1294  
1295  
1296  
1297  
1298  
1299  
1300  
1301  
1302  
1303  
1304  
1305  
1306  
1307  
1308  
1309  
1310  
1311  
1312  
1313  
1314  
1315  
1316  
1317  
1318  
1319  
1320  
1321  
1322  
1323  
1324  
1325  
1326  
1327  
1328  
1329  
1330  
1331  
1332  
1333  
1334  
1335  
1336  
1337  
1338  
1339  
1340  
1341  
1342  
1343  
1344  
1345  
1346  
1347  
1348  
1349  
1350  
1351  
1352  
1353  
1354  
1355  
1356  
1357  
1358  
1359  
1360  
1361  
1362  
1363  
1364  
1365  
1366  
1367  
1368  
1369  
1370  
1371  
1372  
1373  
1374  
1375  
1376  
1377  
1378  
1379  
1380  
1381  
1382  
1383  
1384  
1385  
1386  
1387  
1388  
1389  
1390  
1391  
1392  
1393  
1394  
1395  
1396  
1397  
1398  
1399  
1400  
1401  
1402  
1403  
1404  
1405  
1406  
1407  
1408  
1409  
1410  
1411  
1412  
1413  
1414  
1415  
1416  
1417  
1418  
1419  
1420  
1421  
1422  
1423  
1424  
1425  
1426  
1427  
1428  
1429  
1430  
1431  
1432  
1433  
1434  
1435  
1436  
1437  
1438  
1439  
1440  
1441  
1442  
1443  
1444  
1445  
1446  
1447  
1448  
1449  
1450  
1451  
1452  
1453  
1454  
1455  
1456  
1457  
1458  
1459  
1460  
1461  
1462  
1463  
1464  
1465  
1466  
1467  
1468  
1469  
1470  
1471  
1472  
1473  
1474  
1475  
1476  
1477  
1478  
1479  
1480  
1481  
1482  
1483  
1484  
1485  
1486  
1487  
1488  
1489  
1490  
1491  
1492  
1493  
1494  
1495  
1496  
1497  
1498  
1499  
1500  
1501  
1502  
1503  
1504  
1505  
1506  
1507  
1508  
1509  
1510  
1511  
1512  
1513  
1514  
1515  
1516  
1517  
1518  
1519  
1520  
1521  
1522  
1523  
1524  
1525  
1526  
1527  
1528  
1529  
1530  
1531  
1532  
1533  
1534  
1535  
1536  
1537  
1538  
1539  
1540  
1541  
1542  
1543  
1544  
1545  
1546  
1547  
1548  
1549  
1550  
1551  
1552  
1553  
1554  
1555  
1556  
1557  
1558  
1559  
1560  
1561  
1562  
1563  
1564  
1565  
1566  
1567  
1568  
1569  
1570  
1571  
1572  
1573  
1574  
1575  
1576  
1577  
1578  
1579  
1580  
1581  
1582  
1583  
1584  
1585  
1586  
1587  
1588  
1589  
1590  
1591  
1592  
1593  
1594  
1595  
1596  
1597  
1598  
1599  
1600  
1601  
1602  
1603  
1604  
1605  
1606  
1607  
1608  
1609  
1610  
1611  
1612  
1613  
1614  
1615  
1616  
1617  
1618  
1619  
1620  
1621  
1622  
1623  
1624  
1625  
1626  
1627  
1628  
1629  
1630  
1631  
1632  
1633  
1634  
1635  
1636  
1637  
1638  
1639  
1640  
1641  
1642  
1643  
1644  
1645  
1646  
1647  
1648  
1649  
1650  
1651  
1652  
1653  
1654  
1655  
1656  
1657  
1658  
1659  
1660  
1661  
1662  
1663  
1664  
1665  
1666  
1667  
1668  
1669  
1670  
1671  
1672  
1673  
1674  
1675  
1676  
1677  
1678  
1679  
1680  
1681  
1682  
1683  
1684  
1685  
1686  
1687  
1688  
1689  
1690  
1691  
1692  
1693  
1694  
1695  
1696  
1697  
1698  
1699  
1700  
1701  
1702  
1703  
1704  
1705  
1706  
1707  
1708  
1709  
1710  
1711  
1712  
1713  
1714  
1715  
1716  
1717  
1718  
1719  
1720  
1721  
1722  
1723  
1724  
1725  
1726  
1727  
1728  
1729  
1730  
1731  
1732  
1733  
1734  
1735  
1736  
1737  
1738  
1739  
1740  
1741  
1742  
1743  
1744  
1745  
1746  
1747  
1748  
1749  
1750  
1751  
1752  
1753  
1754  
1755  
1756  
1757  
1758  
1759  
1760  
1761  
1762  
1763  
1764  
1765  
1766  
1767  
1768  
1769  
1770  
1771  
1772  
1773  
1774  
1775  
1776  
1777  
1778  
1779  
1780  
1781  
1782  
1783  
1784  
1785  
1786  
1787  
1788  
1789  
1790  
1791  
1792  
1793  
1794  
1795  
1796  
1797  
1798  
1799  
1800  
1801  
1802  
1803  
1804  
1805  
1806  
1807  
1808  
1809  
1810  
1811  
1812  
1813  
1814  
1815  
1816  
1817  
1818  
1819  
1820  
1821  
1822  
1823  
1824  
1825  
1826  
1827  
1828  
1829  
1830  
1831  
1832  
1833  
1834  
1835  
1836  
1837  
1838  
1839  
1840  
1841  
1842  
1843  
1844  
1845  
1846  
1847  
1848  
1849  
1850  
1851  
1852  
1853  
1854  
1855  
1856  
1857  
1858  
1859  
1860  
1861  
1862  
1863  
1864  
1865  
1866  
1867  
1868  
1869  
1870  
1871  
1872  
1873  
1874  
1875  
1876  
1877  
1878  
1879  
1880  
1881  
1882  
1883  
1884  
1885  
1886  
1887  
1888  
1889  
1890  
1891  
1892  
1893  
1894  
1895  
1896  
1897  
1898  
1899  
1900  
1901  
1902  
1903  
1904  
1905  
1906  
1907  
1908  
1909  
1910  
1911  
1912  
1913  
1914  
1915  
1916  
1917  
1918  
1919  
1920  
1921  
1922  
1923  
1924  
1925  
1926  
1927  
1928  
1929  
1930  
1931  
1932  
1933  
1934  
1935  
1936  
1937  
1938  
1939  
1940  
1941  
1942  
1943  
1944  
1945  
1946  
1947  
1948  
1949  
1950  
1951  
1952  
1953  
1954  
1955  
1956  
1957  
1958  
1959  
1960  
1961  
1962  
1963  
1964  
1965  
1966  
1967  
1968  
1969  
1970  
1971  
1972  
1973  
1974  
1975  
1976  
1977  
1978  
1979  
1980  
1981  
1982  
1983  
1984  
1985  
1986  
1987  
1988  
1989  
1990  
1991  
1992  
1993  
1994  
1995  
1996  
1997  
1998  
1999  
2000  
2001  
2002  
2003  
2004  
2005  
2006  
2007  
2008  
2009  
2010  
2011  
2012  
2013  
2014  
2015  
2016  
2017  
2018  
2019  
2020  
2021  
2022  
2023  
2024  
2025  
2026  
2027  
2028  
2029  
2030  
2031  
2032  
2033  
2034  
2035  
2036  
2037  
2038  
2039  
2040  
2041  
2042  
2043  
2044  
2045  
2046  
2047  
2048  
2049  
2050  
2051  
2052  
2053  
2054  
2055  
2056  
2057  
2058  
2059  
2060  
2061  
2062  
2063  
2064  
2065  
2066  
2067  
2068  
2069  
2070  
2071  
2072  
2073  
2074  
2075  
2076  
2077  
2078  
2079  
2080  
2081  
2082  
2083  
2084  
2085  
2086  
2087  
2088  
2089  
2090  
2091  
2092  
2093  
2094  
2095  
2096  
2097  
2098  
2099  
2100  
2101  
2102  
2103  
2104  
2105  
2106  
2107  
2108  
2109  
2110  
2111  
2112  
2113  
2114  
2115  
2116  
2117  
2118  
2119  
2120  
2121  
2122  
2123  
2124  
2125  
2126  
2127  
2128  
2129  
2130  
2131  
2132  
2133  
2134  
2135  
2136  
2137  
2138  
2139  
2140  
2141  
2142  
2143  
2144  
2145  
2146  
2147  
2148  
2149  
2150  
2151  
2152  
2153  
2154  
2155  
2156  
2157  
2158  
2159  
2160  
2161  
2162  
2163  
2164  
2165  
2166  
2167  
2168  
2169  
2170  
2171  
2172  
2173  
2174  
2175  
2176  
2177  
2178  
2179  
2180  
2181  
2182  
2183  
2184  
2185  
2186  
2187  
2188  
2189  
2190  
2191  
2192  
2193  
2194  
2195  
2196  
2197  
2198  
2199  
22

## ABSTRACT OF THE DISCLOSURE

A signal processing system and method. The inventive system includes a first  
5 circuit for distributing an input signal between two or more channels in a current mode  
of operation. A second circuit is disposed in each of the channels for processing the  
input signal and providing an output signal in response thereto. A third circuit is  
provided to combine the signals output by the processing circuit. A fourth circuit is  
included for controlling the first and the third circuits. In a specific illustrative  
10 embodiment, the system further includes a radio frequency stage for downconverting a  
received signal and providing the input signal in response thereto. In the specific  
embodiment, the first circuit includes a mixing circuit. The mixing circuit includes  
Gilbert cells and circuitry for providing automatic gain control for each of the channels  
individually. The Gilbert cells and the automatic gain control circuitry are driven by a  
15 transconductance amplifier and therefore operate in a current mode. Differential digital  
automatic gain control signals are provided in response to a channel select signal from a  
digital control circuit. The inventive circuit provides multiple IF channels which may be  
filtered individually. The invention thereby provides wide band operation in a simple,  
single stage implementation that consumes little power. Further, the current mode  
20 thereof is effective in the reduction of insertion loss.

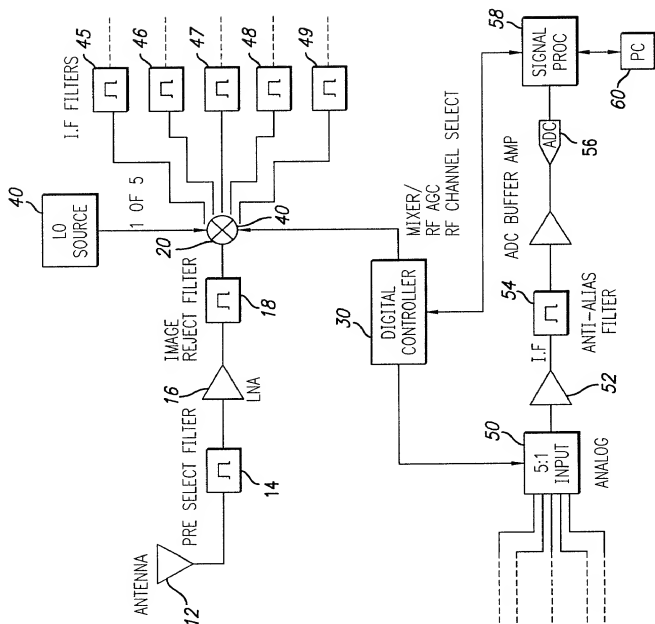


FIG. 1

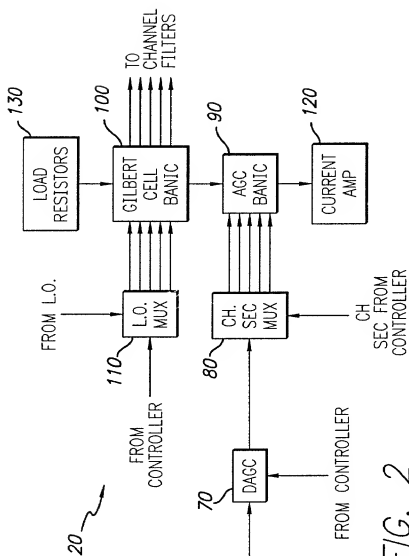


FIG. 2

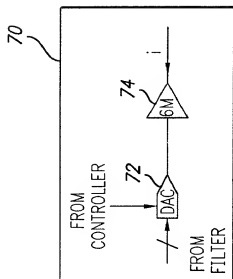
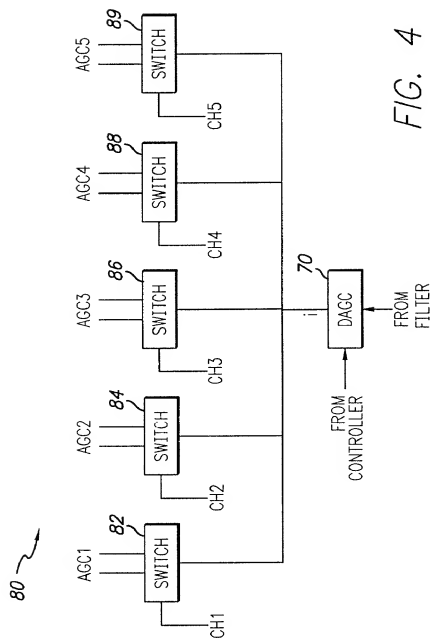


FIG. 3



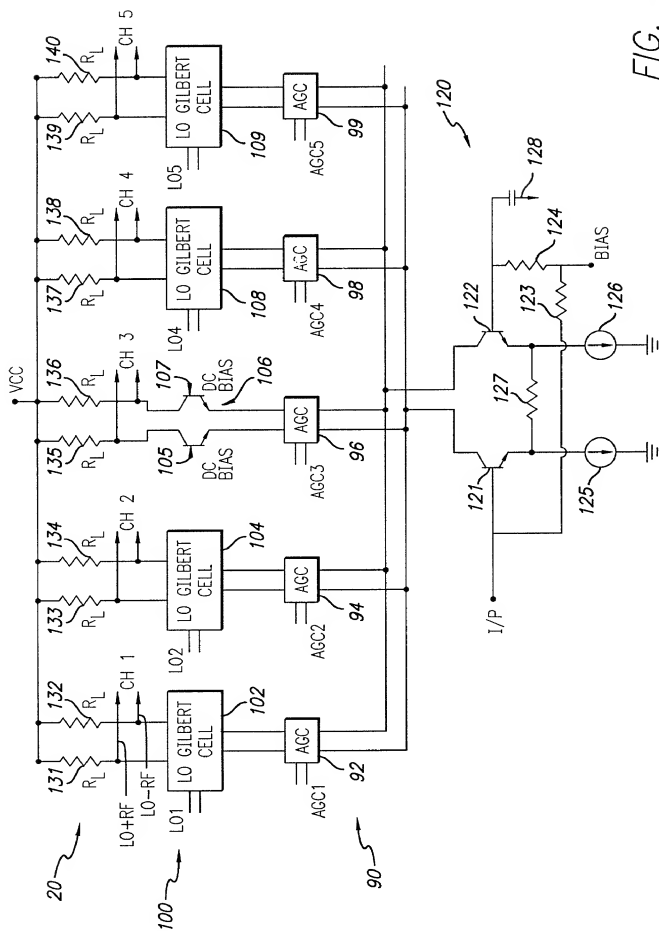


FIG. 5

109

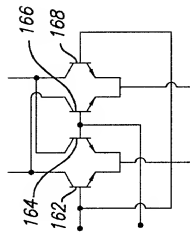


FIG. 7

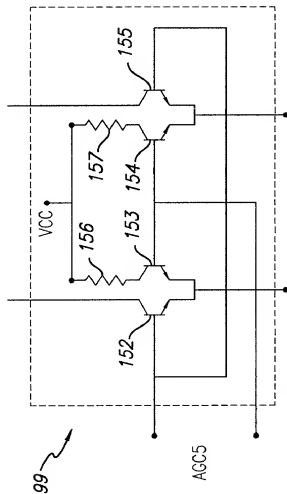


FIG. 6

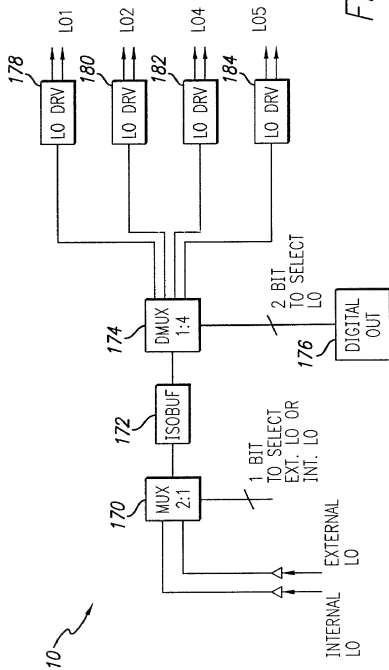


FIG. 8

Please type a plus sign (+) inside this box → ☐

PTO/SB/01 (12-97)  
Approved for use through 9/30/00. OMB 0651-0032  
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE  
Under the Paperwork Reduction Act of 1995, no person is required to respond to a collection of information unless it contains a valid OMB control number.

# **DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)**

☒ Declaration Submitted with Initial Filing **OR** ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	PD-99W166
First Named Inventor	Linder
<b>COMPLETE IF KNOWN</b>	
Application Number	/
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"Low Noise, Low Distortion, Muxable Gilbert Mixer Signal Processing System  
and Method with AGC Functionality"

the specification of which (Title of the invention)

☒ is attached hereto  
OR

☐ was filed on (MM/DD/YYYY) as United States Application Number or PCT International

Application Number and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
			<input type="checkbox"/>	YES	NO
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
		<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

Page 1 of 3

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

Please type a plus sign (+) inside this box ☐

PTO/SB/01 (12-87)  
Approved for use through 9/30/00. OMB 0651-0032  
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE  
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

## DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.86 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

☐ Customer Number  ☐ Registered practitioner(s) name/registration number listed below

OR

☐ Registered practitioner(s) name/registration number listed below

Place Customer Number Bar Code Label here

Name	Registration Number	Name	Registration Number
Leonard A. Alkov	30,021		
Glenn H. Lenzen, Jr.	29,320		
Colin M. Raufer	40,781		
William C. Schubert	30,102		

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☐ Customer Number or Bar Code Label  OR ☒ Correspondence address below

Name	Leonard A. Alkov, Esq.				
Address	Raytheon Company				
Address	P.O. Box 902 (E1/E150)				
City	El Segundo	State	CA	ZIP	90245-0902
Country	USA	Telephone	310.647.2577	Fax	310.647.2616

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:		<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any))		Family Name or Surname			
Lloyd F.		Linder			
Inventor's Signature				Date	05/18/02
Residence: City	Agoura Hills	State	CA	Country	USA
Post Office Address	3730 Patrick Henry				
Post Office Address					
City	Agoura Hills	State	CA	ZIP	91301
Country	USA				

☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

Please type a plus sign (+) inside this box → ☐

PTO/SB/02A (3-97)  
Approved for use through 9/30/98. OMB 0651-0032  
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

<b>DECLARATION</b>	<b>ADDITIONAL INVENTOR(S)</b> <b>Supplemental Sheet</b> Page <u>3</u> of <u>3</u>
--------------------	---

Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])				Family Name or Surname			
Clifford N.				Duong			
Inventor's Signature	<i>Cliff Duong</i>					Date	05/23/07
Residence: City	Fountain Valley	State	CA	Country	USA	Citizenship	USA
Post Office Address 9119 La Estrella Avenue							
Post Office Address							
City	Fountain Valley	State	CA	ZIP	92708	Country	USA
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])				Family Name or Surname			
Don C.				Devendorf			
Inventor's Signature	<i>Don C. Devendorf</i>					Date	5/16/07
Residence: City	Carlsbad	State	CA	Country	USA	Citizenship	USA
Post Office Address 2016 Caracol Court							
Post Office Address							
City	Carlsbad	State	CA	ZIP	92009	Country	USA
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])				Family Name or Surname			
Inventor's Signature						Date	
Residence: City		State		Country		Citizenship	
Post Office Address							
Post Office Address							
City		State		ZIP		Country	

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.